How Should Technical Communication Students Best Prepare for Careers in Medical Device Companies?

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ABSTRACT

The Twin Cities is a hotspot for the medical device industry, which has a high demand for technical communicators, so many local technical communication students become interested in finding a career in this field. This study asks the question "*how should technical communication students best prepare for careers in medical device companies?*" To investigate it, five technical communicators from four medical device companies in the Twin Cities were interviewed about technical communication in the field, possible challenges to new communicators, important skills for this career, and their recommendations for new technical communicators to prepare for a career in this field. Key focus areas (KFAs) for students were identified from the interview results and compared to curricula at the University of Minnesota (UMN). Strengths and gaps were identified between the two, and recommendations on how students should fill those gaps were provided. The goal is to make technical communication students better candidates for positions at medical device companies and increase their success.

THE MEDICAL DEVICE INDUSTRY

The greater-Twin Cities area is a mecca for the medical device (often called medtech) industry; many medical device giants, such Medtronic, 3M, and St. Jude Medical, and hundreds of smaller companies are headquartered here. Minnesota has the second-highest employment rate in the medical device sector in the United States, with nearly 30,000 employees, and has the highest number of medical device patents per capita (Minnesota Department of Employment and Economic Development, 2014)

Because the Twin Cities is a hotspot for the medical device industry, which has a high demand for technical communicators, many local technical communication students choose to go into this industry when they graduate. However, breaking into any industry can be difficult for someone with little or no experience, and figuring out how to prepare oneself can be an intimidating task. Very little research has been done on preparing for technical communication careers in specific industries, and the little literature available is fairly old and focuses on the field of technical communication as a whole and not on any particular industries or subject matter. However, the technical communication field is changing, and the needs/expectations of one industry, such as medical devices, may be more specific than the needs/expectations of the general technical communication field. I ask, "*how should students best prepare for technical communication careers in medical device companies?*"

I interviewed five technical communicators from four separate medical device companies and asked them about technical communication in the field, possible challenges to new communicators, important skills for this career, and their recommendations for new technical communicators to prepare for a career in this field. In this paper, I report my findings of these interviews and compare them to the current curriculum of the University of Minnesota's (UMN) scientific and technical communication undergraduate and Master's programs, and then I identify the gaps between curriculum and practice and make recommendations on how students can fill those gaps.

While this paper is aimed at scientific and technical communication students at UMN, who may have developed interest in the field by proximity to the numerous companies, these findings can be extended to students in technical communications programs at other schools to identify gaps and strengths in their curricula. Instructors may also use this information to modify their courses or find ways to improve their students' success. Lastly, hiring managers may use this information to gain a sense of the training students receive and identify areas in which new technical communicators may be deficient and need additional training.

Roots of Medical Alley

At the 31st Annual International Conference of the Institute of Electrical and Electronics Engineers (IEEE) in Minneapolis, David Rhees (2009) described the history of "Medical Alley," a network of medical device companies in Minnesota. Medtronic has had one of the strongest influences in the rise of Medical Alley. Founded by Earl Bakken and Palmer Hermundslie in 1949, Medtronic began in Bakken's garage where they repaired and sold medical equipment and eventually designed and produced devices. Their first major breakthrough occurred 1957 when they designed a wearable, battery-powered pacemaker at the request of Dr. C. Walton Lillehei, a surgeon at UMN who pioneered open-heart surgery (Figure 1). Following this accomplishment, Medtronic began producing and selling cardiac pacemakers in 1960. In the years following, numerous spin-off companies, over 35 by one estimate, were founded by former Medtronic employees, including Cardiac Pacemakers, Inc. (now part of Boston Scientific) in 1972 and St. Jude Medical in 1976. Since then, the number of medical device companies in the Twin Cities has been on the rise.

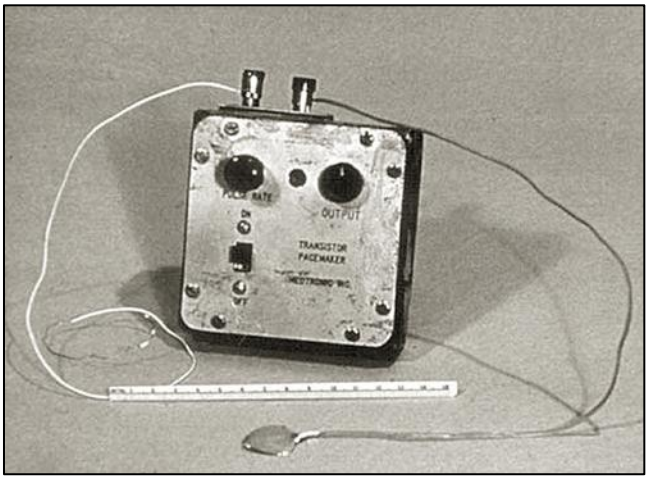

Figure 1. The first wearable pacemaker was created in 1957. (source: http://www.earlbakken.com/content/photos/photos.html)

By 1984, Medical Alley was founded as a nonprofit trade association "to support Minnesota's healthcare industry," and then the Minnesota chapter of the Biotechnology Industry Association, MNBIO, formed in 1991 (LifeScience Alley, 2014). These two associations merged in 2005 to become LifeScience Alley, with the mission of "enabling business success in the life sciences." It is currently the largest state-based life science trade association in the United States, with almost 700 organizations in the life sciences industry, including companies specializing in medical devices, pharmaceuticals, industry support systems, and biosciences. Over 200 of these organizations are specifically medical device companies, including Medtronic, St. Jude Medical, and Boston Scientific.

Why choose a career in the medical device industry?

Technical communication students living in the Twin Cities are in a convenient location for technical communication jobs, whether they look for careers in software, engineering, or medicine. However, Minnesota is especially well known for medical research, since it is home to the Mayo Clinic, UMN, and Medtronic. Many notable medical advances, particularly in the cardiovascular area, have been made in the Twin Cities, including the first successful open-heart surgery, the first cardiac pacemaker, and a working rat heart grown from stem cells (University of Minnesota, 2013a; Morrison, 2009). Medical research is extremely important to save and improve lives of people, so the development and production of medical devices will likely remain strong in upcoming years. In fact, between 2005 and 2012, the employment in Minnesota device companies increased by 2,200 jobs, the third largest growth in this industry nationally (Minnesota Department of Employment and Economic Development, 2014).

Even though some of the most well-known break-through medical devices from Minnesota are in cardiovascular devices, other companies produce devices in a wide variety of other medical areas, such as neuromodulation, hearing, pharmaceuticals/drug delivery, and hemodialysis, so technical communicators are likely to find careers in whichever medical area is most interesting to them. Also, depending on the size of the company, a technical communicator can be hired for a variety of positions such as technical writer, editor, project manager, or user-experience expert. In a smaller company, a technical communicator may take on multiple roles, such as both writer and editor, and be involved with multiple product lines, while technical communicators in larger companies may take on more specialized roles for single product lines, such as a technical editor for defibrillator manuals. There are also many career levels for technical communicators. Depending on the company, the entry-level technical writer job titles may begin at technical writer I or associate technical writer, and technical communicators can advance to senior technical writer, manager, or even director of technical communication (if the company is very large).

Skilled technical communicators are extremely important to medical device companies. Because many medical device companies manufacture products that are implanted in people, safety is a major concern. Unlike many other industries, such as software, where unclear documentation may only cause frustration to a user, unclear documentation for medical devices may actually injure or kill patients. To avoid safety risks, as well as liability concerns, companies must submit products and documents to the FDA for approval (Figure 2). Documents need to be very clear, consistent, and accurate, and they must follow FDA guidelines. Some companies even distribute their products in other countries, so documents may also need to be written in a way so that they can be easily translated. Medical device companies greatly value technical communicators for their skills to write the documentation and follow specific style guidelines.

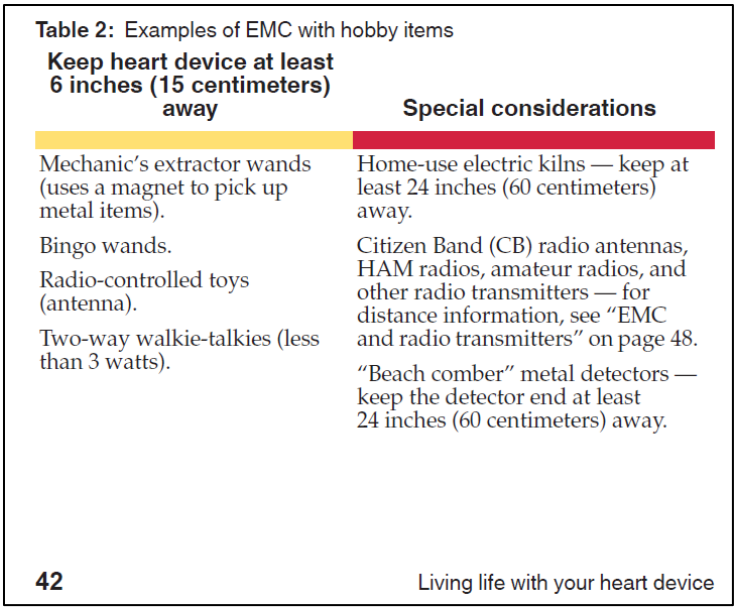

Table 2: Examples of EMC with hobby items

Keep heart device at least 6 inches (15 centimeters) away	Special considerations
Mechanic's extractor wands (uses a magnet to pick up metal items).	Home-use electric kilns — keep at least 24 inches (60 centimeters) away.
Bingo wands.	Citizen Band (CB) radio antennas, HAM radios, amateur radios, and other radio transmitters — for distance information, see "EMC and radio transmitters" on page 48.
Radio-controlled toys (antenna).	"Beach comber" metal detectors — keep the detector end at least 24 inches (60 centimeters) away.
Two-way walkie-talkies (less than 3 watts).	

42 Living life with your heart device

Figure 2. This page from a FDA-approved patient pacemaker manual warns patients about objects that may interfere with the pacemaker's electromagnetic energy field. (source: http://manuals.medtronic.com/wcm/groups/mdtcom_sg/@emanuals/@era/@crdm/documents/documents/contrib_117069.pdf)

Trends in technical communication literature

As mentioned previously, the literature on technical communication in medical device companies is extremely limited, with zero results in Google Scholar and in EBSCOhost Academic Search Premier for article titles that include both "technical communication" and "medical devices." Most literature on the important skillsets in technical communication are broad and somewhat older. However, many of the findings of the older studies are still relevant and useful to know for all technical communicators, regardless of industry. Most of these studies were completed by surveying and interviewing students and professionals and analyzing program curricula. Overall, they illustrated shifts in the roles of technical communicators, going from writers to collaborators and project managers, which needed skills that students seemed to lack at the time.

In one study, Whiteside (2003) identified some of the gaps that technical communication students may need to fill between graduation and entering the workforce. She briefly described how the role of the technical communicator is changing, and as the role expands, "so too does the gap between academic and non-academic discourses" (p. 304). Approximately 60% of recent graduates at the time of the study felt uncomfortable with their knowledge of business operations, and 33% felt they needed to improve their project management skills. In addition, 50% of managers felt that employees lacked in those areas. These are two skills that students

may not have expected to be essential for the field, which indicates that the role of the technical communicator had been shifting away from lone writers. She recommended that technical communication curricula should give more attention to business operations, project management, problem-solving, and scientific knowledge so that graduates can integrate into the workforce more smoothly.

Rainey et al. (2005) found that technical communication managers consider collaboration skills extremely important for technical communicators. In this study, managers rated a list of competencies on a four-point scale of importance, and every manager rated collaboration with subject matter experts (SMEs) as a 4.0 (most important) on this scale, while collaboration with coworkers and writing clearly for a specific audience were a close second and third, respectively. Other extremely important competencies are ability to assess and learn tools and ability to take initiative and evaluate own/other's work. It is interesting to note that the value for collaborative skills are considered just as, if not slightly more, important as writing skills.

Two trends, in which the role of the technical communicator has been evolving, have been described in research conducted specifically at medical device industries. One of these trends is the incorporation of cross-functional teams. In a cross-functional team, instead of working independently on a document, technical communicators collaborate with individuals from other disciplines. The team makeup varies depending on the product and team function, but it can be very diverse, possibly consisting of technical communicators, product managers, engineers, individuals from operations, individuals from legal affairs, and others deemed necessary for a project. In such teams, technical communicators have found they are focusing "less on texts and more on collaborative processes and social interaction" (p. 211) and act more like project managers for a document than the fixed role of a writer (Conklin, 2007). Technical communicators are able to demonstrate their value to colleagues, contribute more to projects, and play a larger role in their organization.

A second trend for medical device companies is single sourcing, which is the act of "producing documents designed to be recombined and reused across projects and various media" (Carter, 2003, p. 317). An example of a single-source document would be a basic microwave operation manual that is used for multiple microwave models. Rather than writing a brand-new manual every time a new model is produced, the single-source document would be customized for each model by combining the single-source document with new content. While single-sourcing may limit a technical communicator's creativity, it maintains consistency across documents. This is extremely useful for the medical device industry, especially when the single-sourced document meets FDA regulations and has been approved to be packaged with previous products. Single-sourcing is also more collaborative in that writers take on sections of a document and piece them together instead of each writer working on single, large documents. Kastman Breuch (2008) shared a case study in which a medical device company switched to single sourcing for their pacemaker and defibrillator documents. Technical writers felt that documents were "better, more

thorough, and more accessible to readers" and that this writing process was more engaging (Kastman Breuch, 2008, p. 345). Reviewers only needed to review the newer material, so they could review smaller chunks rather than an entire document, making the document review process more thorough and helpful to writers.

These studies all demonstrate that technical communicator roles in companies have become more collaborative and focus more on project management. Managers emphasize collaborative and project management skills, which Whiteside noted that many graduates lacked. However, some of this research on managerial expectations is nearly a decade old, and the technical communication field is constantly changing. It is important to update this research to know if expectations in industries are changing and whether curricula are following these changes. Also, different industries will have different expectations, so it will be important for technical communicators entering a particular industry to be aware of differing expectations. This paper focuses on identifying those expectations in the medical device industry and gaps that technical communication students may face when they enter the industry. The goal is to identify how to make technical communication students better candidates for positions at medical device companies and increase their success.

INTERVIEWS WITH TECHNICAL COMMUNICATORS

I interviewed five technical communicators from four large (10,000+ employees in US) medical device companies in the Twin Cities. Due to the large response overlap by the fifth interview, I did not feel that additional subjects were necessary. The interviewees had varying job levels (ranging from technical writer to director of technical communication) and background experiences (little experience prior to entering industry to many years of experience). A convenience sample was used — interviewees were found through personal connections at the companies and selected based on whether they worked as a technical communicator for the company in the last year and have worked there at least six months. Four interviewees currently work for medical device companies, and one technical communicator recently retired. To maintain anonymity, responses will be reported as if all interviewees currently work in the industry. The interviews lasted approximately one hour and were conducted face-to-face, except one interview took place over email per the interviewee's request. I asked each interviewee about their background, job tasks, technical communication trends in the medical device industry, and what skills and knowledge would help new technical communicators and asked follow-up questions when answers needed elaboration (Appendix A). This section reports the results in two sections: trends in technical communication and entering the field.

Trends in technical communication

Tasks/roles of technical communicators

Due to the similarity of responses, this section groups the questions: *"What is your job title and role in the company," "What are typical tasks at your job,"* and *"Describe the stages of developing a document."* This section intends to give new technical communicators a picture of the typical roles and tasks that a technical communicator may have in a medical device company. Generally, they create documents, improve processes, and sometimes work with marketing (Figure 3).

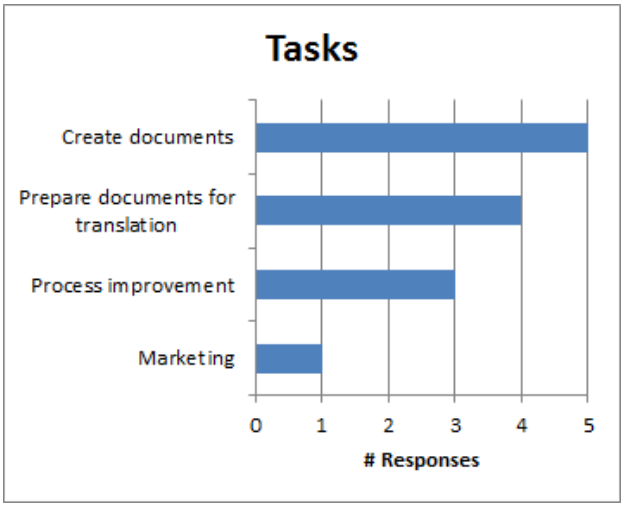

Figure 3. Typical tasks for technical communicators

Creating documents - The primary role for the technical communicators interviewed is creating manuals for the devices that these companies produce. Essentially, they "translate" the technical information from engineers so that they are easy to understand for the users, who may be doctors, nurses, hospital personnel, and/or patients. However, the documents are very rarely created from scratch. Each interviewee uses previous documents to create the current one, sometimes using sections of documents or editing the document for a previous model of the product so that it includes the changes between models. Using older documents saves a lot of time and money for the company. The documents go through a number of reviews, including FDA review, and each change during and after the FDA review process must be documented ("redlined"), including who made the change and why. If the previous documents have been approved by the FDA, only new material needs to undergo FDA review, which speeds up the review process. If the document needs to be translated, which is often done outside the company, the company will only need to pay the translators to translate the new material.

Each interviewee had some variations, but overall the documentation process followed these steps:

1. *Write* - Incorporate new information/changes to similar product's document, redline any changes to document
2. *Review* - Submit document to coworkers or experts to review for accuracy or submit to FDA for review
3. *More writing/reviewing (repeat as necessary)* - Make changes as needed, observe clinical trials with documents if necessary, proofreading, resubmit to review
4. *Product release* - Send document to translations, begin next project

Translation – Some companies have international business and need to translate documents into other languages. Four of the interviewees discussed preparing documents for translation as part of their jobs. They need to make sure the language is clear and simple and uses an active voice so that it will be easy to translate.

Process improvement - Technical communicators do a lot more than just writing at their jobs. One interviewee stated that the amount of writing each day goes in peaks and valleys, but overall writing is only about 30% of the job. Three of the interviewees emphasized process improvement as a major part of their jobs. Involvement will vary depending on job level and department; one interviewee, who is a director of technical communication, stated that 90% of her job is focused on process improvement and trying to answer "how do we best arrange to do our work that's coming our way" and "how do we make sure that work is high quality?" Another interviewee works in the operations department and focuses on determining if tasks can be done cheaper and/or more efficiently. Examples of process improvement include improving filing systems, determining if certain tools would be more efficient at accomplishing tasks, and updating procedures. Communicators may meet with others in the department to receive input on procedures and discuss any potential changes. Once changes are made, communicators may create new instructions/procedure guidelines.

Marketing - One interviewee sometimes has the opportunity to work with marketing to make promotional material for products, such as brochures of products, cover letters to potential buyers, and technical bulletins. These documents describe the characteristics and usefulness of the devices and try to sell them to hospitals and clinics. They are more "flashy and fun" and provide a creative outlet.

How is this industry unique?

Interviewees were asked *"how is technical communication at medical device companies unique from other industries?"* Due to time constraints, one interviewee was not asked this question. However, the other four interviewees unanimously stated that the FDA regulations make the medical device industry unique from other industries. As one interviewee put it, "everything is ruled by the FDA." The restrictions the FDA poses on companies may be challenging for some

technical communicators. Once the FDA approves something, the company often will not allow changes to it because it would need to go through the FDA review again. One interviewee complained "a lot of times there are a couple sentences that have been FDA approved, and I can't change them even if I think they're horribly written." To make changes to an FDA-approved document, a business case needs to be made (e.g., the change could save the company money). A different interviewee stated that sometimes the exact wording of a warning may have been negotiated by multiple people from multiple countries, so there needs to be specific reasons to change it other than "it sounds better." That interviewee also stated that with the harsh regulations, compliance with a device is more likely since people using it know the devices and manuals go through an extensive review process.

Changes in technical communication

Technical communication is a constantly changing field, so technical communicators should know what changes have been made and what changes are expected. The interviewees were asked: *"How is technical communication in this industry changing?"* They responded that documentation is changing, more information is being digitized, technical communicators need to bring in more value than they once did, and the number and process of translations are changing (Figure 4).

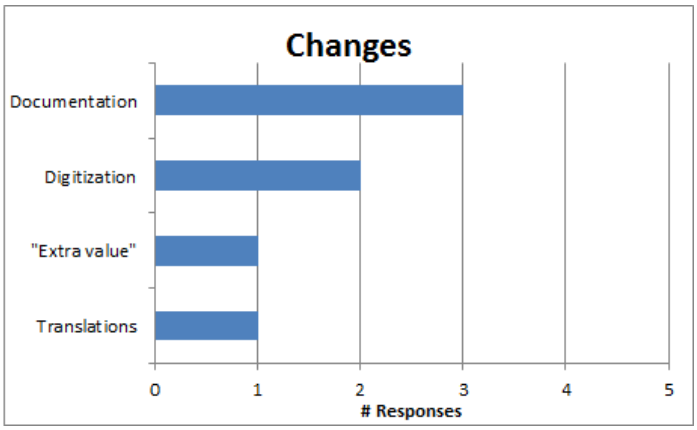

Figure 4. Changes in technical communication in the medical device industry

Documentation - The ways technical communicators put together documents are changing. Three interviewees discussed changes they have seen or changes they expect to see. Two of these interviewees discussed the recent push for content management systems in their companies. These systems help communicators create and manage their documents more efficiently. Technical communicators can easily access previous documents and reuse information for newer products, saving them a lot of writing and reviewing time, especially if the information already has been approved by the FDA. Another interviewee expects that because more and more

companies use FrameMaker, technical communicators will be more responsible for formatting their documents in the future.

Digitization - As the world is becoming more digital, medical device companies are as well. Two interviewees stated that they format their documents for digital use, which one mentioned that the medical device industry is behind other industries for digitizing their documents. This may be due to requirements to package paper documents with products. Europe currently requires documents of products sent to them to be translated into 26 languages, which would take up a lot of shelf space in hospitals, especially since some manuals may be over 500 pages. Digitizing the documents helps them conserve shelf space, and the company can save on printing costs by sending manuals in the country's native language, rather than all 26 languages, and putting the other languages online.

In addition to saving space and costs, digitizing the documents make them more convenient for the user. They can access the documents wherever they have internet access; the increased use of smartphones and tablets makes this possible anywhere. One interviewee stated that users want to find information online fast; "[they] want to type what they want to know in Google and get the answer." Putting the information into usable chunks online and the ability to search for keywords will help them find information more quickly. They will also receive the most up-to-date information for the device. Any changes made to the document can be updated instantly online, and companies do not need to worry about printing and mailing out updated manuals to users.

Need for "extra value" - The role of technical communicators is changing -- they are no longer just writers and have taken on additional roles, such as process improvement as mentioned previously. One interviewee discussed that because liberal arts colleges are emphasizing interdisciplinary learning, engineers nowadays are graduating with better communication skills. Technical communicators must bring in some "extra value" when they apply to a job. They need to be "more agile [and] continuous-improvement minded." Specifically, they need to be able to break down, learn, document, and improve processes. If engineers are able to write better, then technical communicators need to be able to convince the company that they have skills other than writing to make them a worthy investment.

Translations - One interviewee mentioned that documents are being translated to more languages as their company increases business in other countries and that there is also a shift toward using tools for translating documents, particularly programs that use "translation memory." These programs keep track of phrases that have already been translated to specific languages so that they would not need to be translated again if the phrases are reused in new documents. When a document is put into the program, it will translate the phrases it already knows, and it will even pinpoint single words that have changed from sentences it knows. Then, all that need to be sent to human translators are new sentences and changes to the existing

sentences. This is cheaper and more time efficient for the company since less needs to be translated.

Entering the field

Experience

When searching for jobs, it is important to keep in mind how much experience may be needed for a position. Interviewees were asked to *"describe your background experience*" to gain a picture of their educational and work backgrounds that may have made them more ideal candidates, and then follow-up questions were asked about their experience with the subject matter. Four began working as entry-level technical writers in their companies (one worked in a different position for some time prior), and the other was hired as a manager in her company.

Writing experience - The amount of experience before entering the industry greatly varied between the technical communicators, ranging from very little to many years of experience. One interviewee only has a Bachelor's degree in technical communication and was hired by her company right after graduation. This interviewee had some professional experience as a communications intern at a non-profit one summer and was heavily involved in their school's chapter of the Society for Technical Communication. Another interviewee obtained a Bachelor's degree in technical communication and a Master's degree in English, but worked in retail for a time before being hired by a medical device company. With no professional experience as a technical communicator, they kept some skills sharp in the retail job by improving processes, such as record keeping. This interviewee emphasized that if you do not have a lot of experience, know "how to tell your story and how to make your story relevant." She believes that the process improvement helped in obtaining a technical communication job with no professional writing experience.

Two interviewees have had significant experience before entering the medical device industry. One has both Bachelor's and Master's degree in English and has spent many years doing contract work and working as technical communication manager before being hired as a manager in a medical device company. The other obtained a Bachelor's degree in journalism, worked as an editor for a few years, obtained a graduate certificate in technical communication, and then worked as a technical writer for a different industry for a few more years before being hired in a medical device company.

Formal education in technical writing is actually not entirely necessary as long as an individual can demonstrate an ability to write and can bring other skills to the table. One interviewee "did it backwards." He has a Master's degree in biology and worked in the research and development department of a medical device company. This interviewee discovered he enjoyed writing and was subsequently hired as a technical communicator from knowledge of the subject matter ("I

probably could have been considered a subject matter expert at the time") and writing experience gained from within the company.

Subject matter experience - Surprisingly, four of these technical communicators had very little experience or knowledge of the subject matter before entering the industry. One mentioned taking some coursework in biology and human anatomy as an undergraduate student many years prior to being hired at her company, and the other three said they had almost no knowledge of the subject matter. All interviewees agreed that some knowledge of the subject matter (e.g., anatomy/physiology, biology, chemistry) is useful and may give technical communicators an edge on job applications, but a lot of it is also learned on the job through training, talking to the subject matter experts, and observing clinical trials.

Challenges for new technical communicators

Every field has its challenges, and often the expectation of a job may be different than the reality. Knowing some of the challenges and maybe even tackling them beforehand may help new technical communicators integrate more easily in their workplace. Interviewees were asked "*What are some gaps in knowledge or other challenges that technical communicators may face when they are new to this industry?"* They said that interviewees may struggle or have little experience with FDA regulations, project management, tools of the industry, terminology, and business concepts (Figure 5).

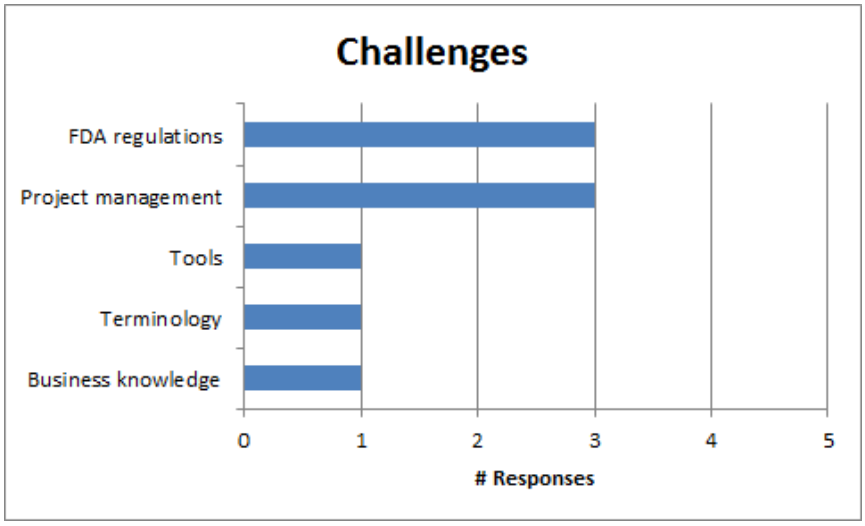

Figure 5. Challenges technical communicators may face when they are new to the medical device industry

FDA regulations - Three of the interviewees emphasized knowledge of FDA regulations as a specific gap in knowledge and challenge to technical communicators when they first enter the medical device industry. Most technical communicators new to the industry do not have any experience with FDA regulations since they are too specific to be covered in college programs.

Classes do exist outside of college curriculum, but one interviewee mentioned that the classes are very expensive and that she would not have been able to take it if her company did not pay for it. That interviewee also mentioned that the FDA regulations would be very difficult to learn independently without the context obtained at work. Another communicator stated that many technical communicators entering the field are unaware of how the FDA regulations affect them and their jobs. As mentioned previously, there is a bit less freedom for creativity for documents because of the FDA regulations, so they will need to find other outlets for creativity. Once something is approved by the FDA, they also cannot change how something is worded, even if they think they can make it sound better.

Project management - Three interviewees responded with project management skills as challenges. One technical communicator specifically listed a lack of project management experience and stated that a lot of programs do not teach project management skills and they are usually learned "trial by fire" on the job. The other two interviewees discussed needing to be able to multitask with multiple projects. One of these two stated that the technical writers in his department are sometimes overwhelmed with the number of projects they need to work on at a given time, and the other described a coworker who struggled by working on projects one at a time. She said "I'm working on five products hardcore right now. If I work on them one at a time, I wouldn't meet my deadlines." Because companies want to put products on the market before competitors, the medical device industry is very fast paced. Technical communicators need to be able to keep up with deadlines and be able to manage multiple projects at once in order to succeed.

Tools - One interviewee said that new technical communicators may not understand the tools when they enter the industry, especially content management systems, and another interviewee wished that he knew more tools before entering the industry, especially XML or HTML, but learning them is extremely time consuming. Technical communication programs do not teach students many, if any, specific industry tools that technical communicators use, so it is up to the students to learn them on their own. Unfortunately, some of these tools are expensive for students to acquire and may have big learning curves, so they can take a while to learn. Other tools, such as content management systems, cannot be learned independently, especially without context.

Terminology - When entering any new field, most people will encounter terminology with which they are unfamiliar. One interviewee said the terminology of the field may be a gap in knowledge for new technical communicators. Medical device companies often use acronyms for products, usually to keep them more secret from outside sources before release, and they will mean different things to different companies. Over time, the technical communicators become more familiar with the specific terminology of the field and will learn the acronyms as the come.

Business knowledge - One interviewee stated that new technical communicators lack knowledge of business concepts and how they fit into the goals of a business. They often do not understand that they cannot change things in a manual without a business case. Those involved in regulation want to be able to show that a product is the same as a predecessor with only a couple changes, and if a writer makes a number of changes to a manual, it becomes more difficult to show that the product is similar to the predecessor.

Important skills/knowledge

The interviewees have each worked in their companies for at least a few years, so based on their experiences and observations of other technical communicators, they have a decent perspective of what the important skills and knowledge that are important for success. When asked *"what skills/knowledge are most useful for a successful career in this industry,"* they responded with people skills, interviewing skills, familiarity with tools, writing/editing skills, ability to learn quickly, project management skills, a fondness for learning, having perspective on productivity, and having a business sense. They were also followed up with *"which of these are typically obtained on the job,"* since a lot skills are learned on the job in many different careers, and developing skills take time (Figure 6).

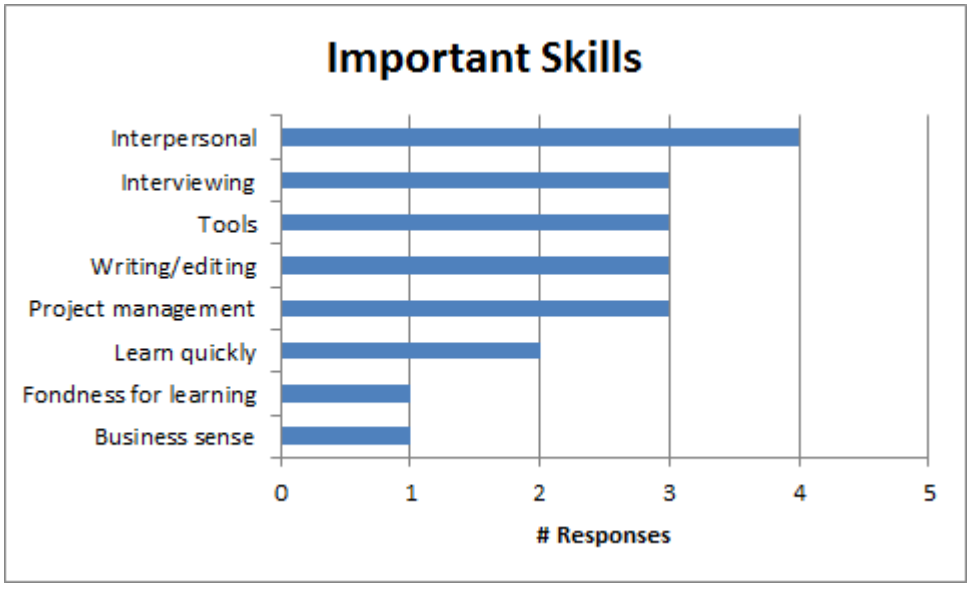

Figure 6. Important skills for technical communicators to be successful in the medical device industry

Interpersonal skills - Because technical communicators need to interact with a number of different people in workplace such as subject matter experts, other communicators, and managers, four interviewees listed interpersonal skills that are essential to be successful in the industry. Specifically, technical communicators need to be personable and able to work in a team with very different people. One interviewee stated that their workplace has both older and younger individuals, so there are sometimes generation gaps in in knowledge and behavior.

Some people also inherently have difficult personalities. It is important to establish good relationships with coworkers because technical communicators rely on others to gain the information needed for documents. Without good relationships, especially with subject matter experts, coworkers may be less eager to help. Many people naturally have excellent people skills, but two interviewees indicated that these skills can be developed on the job. Communicators need to remember that "patience and respect is key."

Interviewing skills - Related to the people skills discussed above, three interviewees said interviewing skills are very important. Technical communicators need to be able to talk to coworkers in person, since a lot of them may be difficult to reach via email, and ask them the right questions to get information they need for the documents. Subject matter experts may not know what is needed for a document or overestimate what the technical communicator already knows and unintentionally leave out information. One interviewee stated that in these situations, technical communicators need to have "a tolerance for being the dumb one," but also keep in mind they will have expertise in areas that others may know little about. Another interviewee indicated that interviewing skills and knowing what questions to ask will improve on the job.

Familiarity with tools - Software tools are used every day by technical communicators, so three interviewees said having a familiarity of at least some basic tools are useful. As mentioned previously, tools take a lot of time to learn, some are expensive, and some cannot be learned without job context. However, understanding some of the more widely available tools, such as Microsoft Office or the Adobe Creative Suite, will help technical communicators learn some of the workplace tools more quickly. One interviewee remarked that tools often change, so "if you're learning new software programs, it will tide you across changes."

Writing/editing skills - Only three interviewees emphasized strong writing/editing skills as important skills for new technical communicators, although that may be because technical communicators are assumed to already have strong writing skills. Technical communicators need to be able to write clearly and concisely in the active voice, rephrase things (such as technical material from subject matter experts), and write content so that it can be translated easily. These skills usually improve on the job with good writing examples and by using them every day.

Project management skills - Unfortunately, project management skills were listed as a gap in knowledge previously, and three interviewees said they were important for success. Technical communicators will work multiple products with different deadlines at any given time, so they need to be able to manage each of their projects and multitask between them, since working on them one at a time will cause missed deadlines. One interviewee stated that it is important for technical communicators to have perspective on their own productivity at work. They need to work hard and have a sense of their productivity levels. They need to be able to ask for help when they need it, and if they cannot get something done, they need to "communicate with peers and management in a positive way" and discuss what can be done. One interviewee said that

multitasking is a skill that technical communicators will "have or don't have," but another said project management skills can be learned on the job.

Ability to learn quickly- Technical communicators have to learn a lot about new products all the time, so two interviewees listed being able to learn technical things quickly as an important skill in the field. When they are new to an industry, technical communicators may not have any experience with some of the tools or products, especially in the medical device field, so they will need to be able to pick up on concepts quickly to be efficient. They need to be able to break down processes and analyze them. New products are developed constantly, so technical communicators cannot spend a lot of time learning about each one.

Fondness for learning - Technical communicators are learning new tools and products frequently, so one interviewee said curiosity and enjoying learning are important traits for technical communicators to have. That interviewee stated that a technical communicator "needs to be somebody who likes technology and likes figuring out how things work."

Business sense - One interviewee stated that technical communicators should bring a business sense to their work. They should understand how they fit into the company's business and be able to let work go for the needs and business constraints of the company. They need to be able to go back and forth between user and business needs and be able to stand back and figure out how to improve things.

Recommendations

Since they were once a new technical communicator trying to enter the field and have seen others do the same, the interviewees are an excellent source of advice to getting into the medical device industry. They were asked "*in what ways could students better prepare for technical communication careers in this industry?*" They recommended gaining practical experience, networking, demonstrating acquired skills, learning tools, becoming familiar with the subject matter, developing intercultural communication skills, and learning business concepts (Figure 7).

Figure 7. Recommendations for new technical communicators to improve their success in the medical device field.

Gain practical experience - Four interviewees suggested gaining as much practical experience as possible, through coursework or internships. One interviewee said the courses that included writing instructions were most useful, and another suggested taking project management courses and wished that she "had known to do that." One interviewee also suggested taking courses with collaborative projects for companies (i.e., the company brings a problem to the class and students find solutions) but cautioned that most of these are offered for industrial engineering students so technical communication students may not have the prerequisites. Outside of the classroom, internships are also useful. They give students workplace and technical writing experience, and they may even give students a foot in the door to the company when they look for technical communication jobs.

Learn tools - Four interviewees recommended that new technical communicators should learn some tools to make them more ideal candidates. Three specifically suggested learning the concepts of tagging languages, such as XML or HTML, and another expressed that he wished he knew one beforehand. Learning a tagging language may help new technical communicators learn how to use content management systems more quickly. Although not every system uses the same tagging language, the concepts between them are very similar. One interviewee also suggested becoming familiar with the some features in the Adobe Creative Suite and FrameMaker.

Network - A lot of jobs today are obtained through networking, which was suggested by two interviewees. According to one, "networking is huge," and the other learned from a connection in the company what to expect in the interview for the technical writer position. To increase

one's network, participate in networking groups, such as LinkedIn, and talk to people in the industry. Attend Society for Technical Communication meetings and talk to people about their work. Some of these people may have connections in the field who are looking for technical communicators, so building connections with those you meet may help you find a job.

Demonstrate skills - Two interviewees suggested finding ways to demonstrate skills to potential employers in the field; one suggested doing this through a solid portfolio. Specifically, technical communicators should demonstrate that they are able to work with regulations, use computer tools, and learn technical information. When putting together a portfolio, include pieces that match what the company will be looking for in a technical communicator, based on research on the company and keywords on job postings, should be included. In addition, using skills in other settings, such as other work settings like one interviewee had, keeps them fresh and can potentially be included in resumes when applying to jobs.

Gain familiarity of subject matter - Most of the subject matter is learned on the job, and most interviewees had very little experience with it before entering the industry, but two interviewees said that some familiarity would be useful to avoid going in completely "cold turkey." Knowledge of medical terminology, human anatomy/physiology, and chemistry may be useful, and introductory courses in these subjects are offered in most colleges. A basic understanding on how FDA regulations will affect their work and the restrictions they will impose will also be very helpful.

Develop intercultural communication skills - Many companies do business internationally and work with other countries. One interviewee said she has colleagues in other countries, so developing intercultural communication skills would be a plus for new technical communicators. It is important to understand cultures can differ significantly and to use plain English with an active voice when communicating with those in a different culture.

Learn business concepts - One interviewee said some knowledge of business is useful for technical communicators, especially if they are interested in working as a manager in the future. They can take business courses or even just read books on product development. That interviewee also recommended attending company business meetings after being hired.

DISCUSSION OF INTERVIEW RESULTS

As mentioned previously, Whiteside's (2003) study found that over half of technical communication managers felt that employees lacked project management skills, problem-solving skills, and knowledge of business operations, and a large number of recent graduates felt they lacked knowledge of business operations (60%), knowledge of software and computer languages (42%), and project management skills (33%). Although the study is over a decade old, new technical communicators still face the challenge of missing some those skills: three out of the

five interviewees said new technical communicators may lack problem management skills, one said tools may be a challenge, and one said new technical communicators may lack business knowledge. Although it may seem that deficiencies in some areas have decreased, the two studies may not be entirely comparable given the number and job levels of the participants (only one had managerial experience, and one graduated three years prior to this study, one year longer than Whiteside's requirement of two years for a "recent graduate"). The main significance is that technical communicators still see deficits in those skills.

As Rainey et al.'s (2005) study emphasized that collaboration with subject matter experts and coworkers as most important for technical communicators, interpersonal skills for working on a team with different people received the most responses for important skills in this study. Interviewing skills when gathering information from subject matter experts tied for second most responses with tools, writing/editing, and project management skills. Interestingly, these match Rainey et al.'s top competencies, which include writing for specific audiences, ability to learn technologies, and ability to take initiative and assess own/other's work (which are important for project management). While Rainey et al. emphasized the ability to learn technologies (tools) quickly, they also recommended technical communicators should learn as many tools as possible; they said the answer to "how much technical knowledge should I have?" is always "more than you have now."

There was very little mention of the cross-functional teams discussed by Conklin (2007) in the interviews; interviewees mostly talked about meeting with SMEs and others in their own department. Cross-functional teams were a new development when Conklin reported his study, so it may be the companies of this study's interviewees have not integrated them yet. However, he did mention that role of technical communicators were changing to those of project managers, rather than just writers, which seemed to be evident in this study, particularly in the discussion of process improvement. On the other hand, single sourcing, discussed by Kastman Breuch (2008) was extremely evident in these companies in the use of their content management systems.

Key Focus areas

In the interviews, I learned about the skills and knowledge that the interviewees felt are important for new technical communicators in the medical device industry. As such, it is important for technical communication students to focus on developing these to increase the candidacy for a position and success after being hired. There are also gaps in knowledge and challenges technical communicators face when they are new in the industry (some of which overlap with important skills/knowledge), so technical communicators should be aware of these and potentially address them prior to hire to integrate more easily in the industry. To determine the key focus areas (KFAs) for technical communication students, I compiled a list of the interviewee responses for important skills/knowledge, challenges/gaps in knowledge, recommendations (relating to skills) and removed duplicate/similar answers. I removed "ability

to learn quickly" and "fondness for learning" from the KFAs, since they describe natural traits of technical communicators that cannot be specifically trained. I have identified eight KFAs, ranked by the number of interviewee responses across the three interview questions:

1. Tools - 8 responses
2. Project management - 6 responses
3. Subject matter (includes FDA regulations and terminology) - 6 responses
4. Interpersonal/collaborative skills - 4 responses
5. Interviewing skills - 3 responses
6. Business concepts - 3 responses
7. Writing/Editing - 3 responses
8. Intercultural communication - 1 response

Lisa Meloncon (2009, 2013) analyzed technical communication undergraduate and Master's programs in the U.S. She coded courses by topics based on their titles and course catalog descriptions. Interestingly, with the exception of writing/editing (which are covered by a number of course topics in her study, such as writing, composition, and communication), there are relatively few courses on the KFAs. The percentage of programs with courses containing the KFAs are covered in Tables 1 and 2 (excluding writing/editing).

Table 1. Mapping of undergraduate courses in Meloncon's study (2013) to KFAs

KFA	Course subject in Meloncon's (2013) study	% with required courses	% with elective courses
Tools	Technology and tools	26	26
Project management	Project management	12	6
Subject matter	Specialized-technical genre	12	8
	Ethics/law[1]	20	17
	Outside department requirement	58	n/a
Interpersonal skills	Collaboration	9	15
Interviewing skills	Research methods	23	15
Business concepts	Specialized-other genre	21	12
Intercultural communication	Intercultural/global	9	18

Table 2. Mapping of Master's courses in Meloncon's study (2009) to KFAs

KFA	Course subject in Meloncon's (2009) study	% with required courses	% offer courses as concentration	% with elective courses
Tools	Technology/tools	10	13	14
Project management	Management	11	15	14
Subject matter	Specialized technical	0	17	27
	Ethics[2]	5	8	5
Interpersonal skills	Other[3]	13	14	24
Interviewing skills	Research methods	48	6	7
Business concepts	Specialized other	1	14	15
Intercultural communication	Intercultural/global	5	11	4

It is a bit concerning how few of the KFAs are covered in required courses or even offered as electives, especially since many are extremely important for many areas outside the medical

[1] This would potentially cover knowledge of FDA regulations.
[2] Ethics may cover FDA regulations in only some classes.
[3] Other may cover interpersonal skills in only some classes.

device industry. As a whole, there is a huge gap between these KFAs and curricula. However, both of these studies included Bachelor of Arts or Master of Arts programs that do not specialize in technical topics and focus more on "professional" writing than "technical writing." The KFAs may be covered in more courses, but since they are not the primary focus of those courses and therefore are not included in course titles or catalog descriptions, they may be underrepresented in Meloncon's studies. The next section will focus specifically on UMN's curricula and identify gaps between curricula and the KFAs.

DISCUSSION OF CURRICULA

UMN offers both Bachelor of Science and Master of Science degrees, in Scientific and Technical Communication (STC), though the undergraduate program will be renamed Technical and Professional Writing in the future. A graduate certificate is also offered but will not be specifically addressed in this paper because of its similarity to the Master's program.[4] In this section, I give an overview of the undergraduate and Master's programs and their student learning outcomes and map the KFAs to program requirements based on information from current syllabi (as of April 2014) for coursework and review by each program's director. Then, I will identify gaps between program requirements and the focus areas. The recommendations will be presented in the next section.

Most students in the STC programs at UMN are familiar with the large medical device industry presence in the Twin Cities, and many choose to pursue careers in this industry because of the high demand for technical communicators and locality. I chose to focus on UMN's programs in particular because UMN is the largest University in the Twin Cities area and is the only school in Minnesota listed on the Society of Technical Communication's website that has both a Bachelor of Science and a Master of Science program and because of personal familiarity with the programs.

Undergraduate program

Overview

As of fall 2012, the undergraduate program in scientific and technical communication requires students to complete 37 credits of courses in the Writing Studies department. Twenty-five of these credits are reserved for seven required core courses plus a senior project, six credits are chosen from eleven oral, written, visual, and digital communication courses, and six credits are chosen from nine science, technology, and society courses (see Appendix B; University of Minnesota, 2014a). In addition, students must complete 15 credits from one of four sub-plans: information technology and design, biological and health sciences, legal discourse and public

[4] Courses for the certificate program are chosen from the same list of courses for the Master's program. The main differences between the two programs is that certificate students complete fewer courses and do not complete courses in a competency area or a capstone project.

policy, and environmental science. Each sub-plan has a list of about 30 courses that students can pick from.

The program has five main learning outcomes that encompass a number of subtopics and are mapped to the courses in the department (see Appendix B for course titles; A.H. Duin, personal communication, March 4, 2014):

- **Written Communication** - writing process, genre, writing competency
  Courses: 3029, 3101, 3102, 3441, 3562, 4573, 4664
- **Rhetorical and Writing Theory** - rhetorical analysis and theory, writing theory
  Courses: 3001, 3101, 3221, 3244, 3701, 3751
- **Technology, Culture, and Society** - ethics, writing in the professions, socio-cultural
  Courses: 3001, 3029, 3102, 3152, 3244, 3315, 3361, 3371, 3381, 3577, 4431, 4464
- **Information Management** - information gathering, project management, content management
  Courses: 3221, 3562, 3671, 3672, 4501, 4573

Mapping KFAs

Now that we have a picture of what the undergraduate program looks like, how do the program requirements/student learning outcomes fit with the KFAs? In Table 3, I match the KFAs to the courses in the program. Courses that do not contain any KFAs are not included in this table. Those courses still teach valuable skills and knowledge, but not those that most important in this specific industry.

Table 3. KFAs in the undergraduate curriculum

	WRIT course	Tools	Project Management	Subject Matter*	Interpersonal Skills	Interviewing Skills	Business Concepts	Writing/ Editing	Intercultural Comm.
Core Courses	3001 - Prof. Practices	-	-	-	-	X	-	-	-
	3221W - Comm. Modes/ Methods	-	-	-	X	-	-	X	-
	3441 - Editing/ Style/Critique	-	-	-	-	-	-	X	-
	3562W - Technical/ Prof. Writing	X	X	-	X	X	-	X	X
	3671 - Visual Rhet./Doc. Design	X	-	-	-	-	-	-	-
	3701W - Rhet. Theory	-	-	-	-	-	-	X	-
	4501 - Usability	-	X	-	X	X	-	-	-
	4995 - Senior Project	-	X	-	-	-	-	-	-
Oral, Written, & Digital Communication	3029W - Business & Prof. Writing	-	-	-	-	-	-	X	-
	3101W - Writing Arguments	-	-	-	-	-	-	X	-
	3102W - Public Writing	-	-	-	-	-	-	-	-
	3244W - Critical Literacies	-	-	-	-	-	-	X	-
	3672W - Project Design/ Development	X	X	-	-	-	-	X	-
	3751W - Writing Consultancy	-	-	-	-	-	-	X	-
	4196 - Internship	-	X	-	-	-	-	-	-
	4573W - Proposals/Grant Management	-	X	-	-	-	-	X	-
	4662W - Writing with Digital Tech.	X	-	-	X	-	-	X	-

	WRIT course	Tools	Project Management	Subject Matter*	Interpersonal Skills	Interviewing Skills	Business Concepts	Writing/ Editing	Intercultural Comm.
Science, Technology, and Society	3152W - Issues of Sci/Tech.	-	-	X	-	-	-	X	-
	3371W - Tech., Society, & Self	-	-	-	-	-	-	X	-
	3381W - Writing & Modern Cultural Movements	-	-	-	-	-	-	-	-
	3577W - Rhet., Tech., & Internet	X	-	-	-	-	-	X	-
	4431W - S&TC & Law	-	-	X†	-	-	-	X	-
	4562 - International Communication	-	-	-	X	X	-	-	X
	4664W - Sci. Writing for Pop. Audiences	-	-	X	-	-	-	X	-

*The biological/health sciences subplan also covers subject matter.
†Covers regulation concepts only

Five of the eight KFAs (tools, project management, interviewing skills, writing, and intercultural communication) match up to required core courses. Two KFAs (subject matter and intercultural communication) match up to courses that students could select from the Science, Technology, and Society and Oral, Written, Visual, and Digital Communication course (non-core courses) lists. Two of the courses mapped to subject matter, 3152 and 4664, do not specifically address the subject matter KFA, but students can choose to explore relevant topics in those courses. Business concepts did not match to any learning outcomes or courses.

Strengths in curriculum - The undergraduate curriculum is strong in a number of KFAs.

- *Tools* – A number of courses cover tools, such as Microsoft Office, Google Drive, social media, content management systems, and research tools.
- *Project management* - Project management is covered in three required courses and several non-core courses. In these courses, students develop research questions, analyze their audience, and complete projects over longer time periods. In the usability course (4501), the project is completed for a client.
- *Subject matter* - Students complete a number of courses outside the department, and assuming that they pick courses in the biological/health sciences subplan, they will develop a broad knowledge of this subject matter.

- *Interpersonal skills* - Many of the courses, of which three are required, have a collaborative component to them, so students gain many opportunities to develop interpersonal communication skills to work with different personalities and schedules.
- *Interviewing skills* - Several courses have projects that require students to develop questions and interview others for information. Three of these courses are required.
- *Writing/editing* - As S&TC is housed in the Department of Writing Studies, many of the courses focus on improving writing and editing skills. Students receive feedback from instructors and peers on written work and make revisions based on this feedback. The program is strongest in this KFA.

Gaps in curriculum and potential misses - There is one major gap between curriculum and KFAs and two KFAs that students could easily miss.

- *Business concepts* - No specific courses cover business concepts. Although "business" is included in the course title, Business and Professional Writing (3029) focuses on writing in the business setting (e.g., business letters/emails) and not on business concepts (e.g., operations, business needs/constraints).
- *Subject matter (regulations)* - One course in the department, Intersections of S&TC and law (4431), covers health law and medical-product liability. However, students may not take this course due to scheduling conflicts or interest in other courses that fulfill the science, technology, and society requirements. Courses in the biological/health sciences subplan cover more broad topics (e.g., biology and anatomy), and so they are unlikely to discuss FDA regulations of devices.
- *International communication* – Two courses cover international communication. One course, Technical and Professional Writing (3562), touches on writing for global audiences as part of the audience analysis course objective. The other course, International Professional Communication (4562), focuses primarily on this KFA, but since it is not a core course (students may decide to take other courses to fulfill the science, technology, and society course requirements) and it is only offered periodically, students may not take it (University of Minnesota, 2014a).

Master's program

Overview

The Master's program in STC at UMN requires students complete 30 credits - 21 credits selected from 12 courses in the Writing Studies department and nine credits in a competency area outside of the department that the student chooses (Appendix C; University of Minnesota, 2013b). There are no "core" courses; instead, students work with their advisor to select courses that fulfill writing, information design, and international competencies.

In a pilot program to develop the Graduate School-wide student learning outcomes, faculty of the STC Master's program determined six student learning outcomes from required courses in the program (A.H. Duin, personal communication, March 4, 2014). These learning outcomes will be refined after further input from alumni, faculty in related fields, and key industries.

- Envision and conduct research to meet user and strategic work needs
- Apply STC to a specific industry
- Apply rhetorical theory/principles to STC
- Lead local/virtual/global teams in the design, development, and evaluation of STC
- Construct and foster connected, collaborative, interactive environments

Mapping KFAs

In Table 4, I map the KFAs to the current student learning outcomes and the courses that cover them. Students can choose a wide variety of competency areas, so for simplicity, I will assume students interested in the medical device industry are taking health sciences/medicine-related courses for their competency. From this point, "competency area" will refer to a competency in health science, medicine, or similar areas. Again, courses that do not contain KFAs are not included in the table.

Table 4. KFAs in the Master's curriculum

WRIT course	Tools	Project Management	Subject Matter*	Interpersonal Skills	Interviewing Skills	Business Concepts	Writing/ Editing	Intercultural Comm.
4431W - S&TC & Law	-	-	X†	-	-	-	-	-
4501 - Usability	-	X	-	X	X	-	-	-
4573W - Proposals/Grant Management	-	X	-	-	-	-	X	-
4562 - International Communication	-	-	-	X	X	-	-	X
4662W - Writing with Digital Tech.	X	-	-	-	-	-	X	-
4664W - Science Writing for Pop. Audiences	-	-	X	-	-	-	X	-
5001 - Grad. Studies in S&TC	X	-	X†	X	X	-	-	X
5270 - Writing for Publication	-	-	-	-	-	-	X	-
5112 - Info. Design	X	X	-	X	-	-	-	X
5561 - Editing/ Style for Tech. Comm.	-	-	-	-	-	-	X	-
8505 - Prof. Practice	X	X	-	-	-	-	X	-

*Competency area courses will also cover subject matter.
†Covers regulation concepts only

All of the KFAs except business concepts fit into the student learning outcomes and courses. The capstone project, completed in 8505 or independently, that students must complete to graduate may cover more KFAs (e.g., interviewing skills) depending on the topic and methodology of the project.

Strengths in curriculum - Many of the courses overlap for undergraduate and graduate curricula, so the graduate curriculum sees most of the same strengths as the undergraduate curricula.

- *Tools* - Several courses cover tools that technical communicators use, similarly to the courses from the undergraduate curricula.

- *Subject matter* - Master's students will cover the subject matter in the competency area. They can also take S&TC and Law (4431) to learn about health law and medical-device liability. Introduction to Graduate Studies in S&TC (5001), which many if not most students take, has a unit on regulations in technical communication which cover how legal regulations (including FDA regulations) affect technical communicators in the workplace.
- *Interpersonal skills* - Several courses have collaborative components, in which students must learn to communicate effectively with teammates and work with differing personalities, and one course, Intercultural Communication (4562), covers working in intercultural/global teams.
- *Interviewing skills* - Several courses include projects that require developing interview questions and interviewing others.
- *Writing/editing* - Similar to the undergraduate curriculum, the Master's curriculum is strongest in improving writing skills. Many courses focus on writing, reviewing, and revising.

Gaps between curriculum and KFAs - The main gap between Master's program curricula and the KFAs is that no specific coursework addresses business concepts.

RECOMMENDATIONS

In this section, I will make recommendations for technical communication students to address the gap in business concepts between curricula and the KFAs identified from the interviews and ways to further develop the KFAs that students may miss due to scheduling constraints. Since some of the gaps overlap between the undergraduate and Master's programs, and both groups can benefit from the recommendations regardless of if there is a gap or not, I will not differentiate the recommendations for the programs.

Recommendations to fill gaps

Coursework

If there is room in schedules, students can fill the gaps with other courses. However, some schedules, particularly those of students who also work or are near graduation, may not be able to fit many extra courses. For that reason, recommendations for coursework are ordered by importance/usefulness.

Subplan/competency courses and subject matter - Students in both programs have credits allocated for coursework in the subject matter. Plan out coursework ahead of time to fit in courses most relevant to companies of interest. For example, human anatomy and physiology would be extremely useful for companies that specialize in implantable devices, and chemistry would be useful for companies that specialize in drug administration or diagnostic tools. Medical

terminology will likely be useful in most companies. Undergraduate students, who choose credits for the two subtopics, should choose courses that cover the KFAs as listed in Table 3, such as 4431 (law/regulations) and 4662 (tools) to fulfill science, technology, and society requirements. Master's students can also take those courses to fulfill degree requirements, although only nine credits of 4xxx-level classes can count towards the degree. Students can also as electives if they have space in their schedules.

Business or organizational psychology - Neither of the programs, nor many in Meloncon's studies (included as specialized-other genre courses), address business concepts, even though business concepts are extremely important for technical communicators to know how they fit into their company's business goals. Taking an introductory business or management course will help learn some of the concepts to understand this. One of the interviewees of Rainey et al.'s (2005) study recommended taking an organizational psychology course, which will also address some of those concepts and help understand some workplace dynamics between employees.

International Communication - International communication is covered by multiple courses in the Master's program but is covered by only one undergraduate course that is offered periodically. Coursework in a second language or about other cultures will also help raise awareness of how cultural differences can pose challenges in communication. Students learning a second language can participate in UMN's TandemPlus program[5], in which they will be paired up with a student who is native in that language and learning English as a second language. Through this, students can not only develop their own and another's second language skills but also identify communication gaps between themselves and those in other cultures.

Outside of coursework

If coursework of the subject areas above cannot be taken, students could still learn about them elsewhere through independent studying or reading books on them. I have recommendations to fill the gaps outside the coursework as well. Again, they are ordered by importance/usefulness.

Get practical experience/internships - Interviewees recommended getting practical experience, and one of the ways to accomplish this is through internships. If the internship is closer to the medical device field, the experience and skills gained may transfer more easily to future jobs in the field. Chances are high that some of the gaps may be covered by the internship, especially some of the tools used in the workplace. Even if the internship is not too close to the medical device field, the writing and collaborative experience is extremely valuable. Approximately 58% of the undergraduate programs and 29% of the Master's programs Meloncon's (2013, 2009) studies. UMN does not require internships for either program but lets students use them towards their degree; up to three credits can count towards Oral, Written, Visual, and Digital Communication for undergraduate students, and up to three credits can count towards the

[5] https://languagecenter.cla.umn.edu/tandem.php

competency area for Master's students. Since many students have jobs, some of which may be full-time, they may not have time for an internship, so when they choose classes, they should select courses that include projects that most closely resemble tasks they will do in the workplace, such as courses that cover instructions or collaborative research.

Learn tools - Play around and get familiar with as many tools as possible, especially tagging languages such as HTML or XML. As mentioned previously, knowledge of one tool may help learn another similar tool. Current students at the can also take advantage of software training courses[6] and Lynda.com online tutorials (University of Minnesota, 2014). Some of UMN computer labs have programs installed, such as the Adobe Suite, so students can visit the computers and try out some of the programs without purchasing a license.

Assess and brush up on knowledge/skills - Students should assess how comfortable they are with some of the KFAs, and brush up on them whenever needed. For example, FDA regulations may be only covered briefly in the introductory technical writing courses to both the undergraduate and graduate students. If students feel that they do not quite grasp how they will be affected by the regulations, they may want to take some time and learn a little bit more about them.

Additional Recommendations

I would like to reiterate two of the recommendations interviewees made that were not incorporated into the KFAs but are incredibly important, networking and demonstrating skills.

Networking - A lot can be learned from other people, so networking with technical communicators in the medical device industry may help learn more about the field. It can also help students develop interviewing skills when they ask these technical communicators about their work. The technical communicators also may be able to connect you to others with extensive knowledge in subjects of interest or to those looking to hire new technical communicators. Today, sometimes knowing the right people is key to learning about and getting some jobs.

Demonstrating skills - Using the acquired technical communication skills whenever possible can keep them sharp, and they can potentially be included in a resume or portfolio. One interviewee used her process improvement skills in her retail job, even though it was above her job level, and she was able to use that experience to help her find a job. It is also important to put together a strong portfolio to show off skills, because it is usually how managers determine a technical communicator's ability to write. Pieces that demonstrate other abilities, such as being able to learn and write about very technical information or collaboration skills, are important assets for a strong portfolio.

[6] See http://www.oit.umn.edu/training/ for courses and student access to Lynda.com.

CONCLUSION

In this paper, I investigated the question: "how should technical communication students prepare for careers in medical device companies." I discussed the technical communication trends in the medical device industry and past research on technical communicator competencies. To get a better focus on the medical device industry, I interviewed five technical communicators of varying levels from four medical device companies in the Twin Cities area. I asked them about their job roles and tasks, how the industry is unique, changes in the field, challenges new technical communicators face, important skills/knowledge, and their recommendations for students. Then, I identified KFAs and mapped them to technical communication curricula at UMN, identified the gaps between the KFAs and curricula, and gave recommendations to fill those gaps. Technical communication students should take coursework that addresses industry subject matter, business concepts, and intercultural communication, gain practical experience (such as through internships), learn tools, assess and brush up on important knowledge/skills in the field, network, and demonstrate skills whenever possible. These recommendations should help current technical communication students better prepare themselves for technical communication careers in the medical device industry.

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APPENDIX A
Interview Questions

1. Describe your background experience.
2. What are typical tasks at your job?
3. Describe the stages of developing a document.
4. How is technical communication at medical device companies unique from other industries?
5. How is technical communication in this industry changing?
6. What skills/knowledge are most useful for a successful career in this industry?
    a. Which of these are typically obtained on the job?
7. What are some gaps in knowledge or other challenges that technical communicators may face when they are new to this industry?
8. In what ways could students better prepare for technical communication careers in this industry?

APPENDIX B

Undergraduate program courses

Core Courses (all required)	Credits	Oral, Written, and Digital Communication (choose 6 credits)	Credits	Science, Technology, and Society (choose 6 credits)	Credits
WRIT 3001: Professional Practices	3	WRIT 3029W: Business and Professional Writing	3	WRIT 3152W: Writing on Issues of Science and Technology	4
WRIT 3221W: Communication Modes & Methods	4	WRIT 3101W: Writing Arguments	3	WRIT 3315: Writing on Issues of Land & Environment	3
WRIT 3441: Editing, Style, and Critique	3	WRIT 3102W: Public Writing	3	WRIT 3361: Literature of Social Movements in the United States: 1950 to 2000	3
WRIT 3562W: Technical and Professional Writing	4	WRIT 3244W: Critical Literacies: How Words Change the World	3	WRIT 3371: Technology, Society, and Self	3
WRIT 3671: Visual Rhetoric and Document Design	3	WRIT 3257: Scientific and Technical Presentations	3	WRIT 3381W: Writing and Modern Cultural Movements	3
WRIT 4501: Usability and Human Factors in Technical Comm.	3	WRIT 3533: Roles of the Reader	3	WRIT 3577W: Rhetoric, Technology, and the Internet	3
WRIT 4995: Senior Project	1	WRIT 3672W: Project Design/Development	3	WRIT 4431W: Intersections of STC and Law	3
Subplan courses	15	WRIT 3751W: Seminar: Theory and Practice of Writing Consultancy	3	WRIT 4562: Theory and Practice in International Business Communication	3
		WRIT 4196: Internship in Scientific and Technical Communication	3	WRIT 4664W: Science Writing for Popular Audiences	3
		WRIT 4573W: Writing Proposals and Grant Management	3		
		WRIT 4662W: Writing with Digital Technologies	4		

APPENDIX C
Master's program curriculum

Courses (pick 21 credits + related field competency area)	Credits
WRIT 4431: Intersections of Scientific & Technical Communication and Law	3
WRIT 4501: Usability and Human Factors in Technical Communication	3
WRIT 4562: International Professional Communication	3
WRIT 4573W: Writing Proposals and Grant Management	3
WRIT 4662W: Writing with Digital Technologies	4
WRIT 4664W: Science Writing for Popular Audiences	3
WRIT 5001: Introduction to Graduate Studies in Scientific & Technical Communication	3
WRIT 5112: Information Design	3
WRIT 5270: Writing for Publication	3
WRIT 5561 Editing and Style for Technical Communicators	3
WRIT 5671 Visual Rhetoric	3
WRIT 8505 Professional Practice Capstone Course	3
Related field competency area	9